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TITLE OF THE INVENTION

## PHOTOGRAPHING SYSTEM

BACKGROUND OF THE INVENTIONField of the Invention

The present invention relates to a photographing lens unit for a stereoscopic or "3-D" photographing lens unit, a photographing apparatus, and a photographing lens system.

Description of the Related Art

Fig. 6 shows the configuration of a stereoscopic photographing lens unit according to a conventional example. The basic configuration of a stereoscopic photographing and recording apparatus will be explained with reference to Fig. 6. The stereoscopic photographing and recording apparatus employs a field time sharing method, and is based on an interlaced video system as in the NTSC. Specifically, images equivalent to those viewed by one eye and images equivalent to those viewed by the other eye are sorted into odd fields and even fields.

Referring to Fig. 6, an optical system is separated to right and left sections at the end adjacent to an object, and adapted to admit only right or left beam of light by the function of liquid crystal shutters 81R and 81L disposed on

the right and left sides, respectively.

The beams of light are merged into a single beam of light by mirrors 82R, 82L, and 83, and pass through a stop 84 to be formed into an image at an image pick-up device 88 through lenses 85, 86, and 87. At a given timing, only one of the right and left beam of light reaches an imaging surface.

A picture signal obtained by photoelectrically converting the beam of light formed into an image on the imaging surface as described above is recorded to a recording medium.

Among several different types of information involved in the stereoscopic, there are some types of information required to view a stereoscopic image further properly at the stage of display.

The information required for the above stereoscopic photographing includes:

(1) Angles of view of an image (vertical and horizontal),

(2) Length of base line: Distance between the points corresponding to right and left eyes, respectively (pupil distance),

(3) Angle of convergence: Inward angles (in degrees) of the optical axes of the right and left eyes,

(4) Whether the odd/even of a field corresponds to

left/right or right/left, and

(5) Distance to a subject (Value measured by a ranging system, such as an AF.

Supplementary information includes:

(6) Information regarding an aperture, and

(7) Shutter speed.

The various types of information mentioned above are owned by an optical unit (lens unit) and a photographing unit (the main unit of a camera) as follows:

(1) Optical unit is responsible for information regarding:

(a) Focal length,

(b) Length of base line,

(c) Angle of convergence, and

(d) Distance to a subject (AF system).

(2) Photographing unit is responsible for information regarding:

(a) Size of a photographing area of an image pick-up device, such as a CCD,

(b) Photoelectric conversion cumulating timing of an image pick-up device, such as a CCD (Time of lag from synchronizing signal), and

(c) Whether a field is an odd or even number.

When viewing a stereoscopic image, in order to reproduce a further improved three-dimensional appearance

thereof, it is desired to properly set the size of a display device and the distance from a viewer to the display device.

For instance, if a person who is 170 cm high is standing at a 3-meter distance, and the angle of view is set so that the person is exactly fitted from the top to bottom of a screen, and the angle of convergence is set to the person at the 3-meter distance, then a screen measuring 170 cm vertically should be disposed at a distance of three meters to directly reproduce and display a stereoscopic image in order to reproduce the image with fidelity.

The relationship between even/odd and left/right of a field is saved in the form of even/odd of the field of a recording picture signal. Hence, as long as the defined relationship in a photographing apparatus is known, right and left images can be correctly reproduced.

Furthermore, if the angle of view, parallax, the angle of convergence, etc. are known, then good images can be reproduced, depending on a display device or setting, such as a viewing distance, thereof.

The angle of view can be obtained by conversion based on the focal length of an optical system if the size of a photographing area of an image pick-up device (CCD) has been decided.

A proper set value for the distance between a display device and a viewer can be determined from the distance to a

subject and the angle of view.

However, in the conventional photographing and recording apparatus described above, the above-mentioned information is not recorded to a recording medium wherein images have been recorded, thus presenting a problem in that only the recording medium to which images have been merely recorded is handed to a third party, and good three-dimensional images cannot always be reproduced if the images are viewed at improper setting.

An incorrect left/right relationship, in particular, has resulted not only in the loss of a three-dimensional appearance but an awkward appearance of images also in some cases.

#### SUMMARY OF THE INVENTION

The present invention has been made with a view toward solving the above problem, and it is an object of the invention to provide a photographing lens unit, a photographing apparatus, and a photographing system that are capable of always reproducing good stereoscopic images.

To this end, according one aspect of the present invention, there is provided a stereoscopic photographing lens unit that is mounted on a camera main unit, and has a first photographing optical axis and a second photographing

optical axis, the stereoscopic photographing lens unit  
having control means for controlling a photographing optical  
system, and transmitting means for transmitting  
predetermined information of the photographing optical  
5 system, including control information provided by the  
control means, to the camera main unit.

According to another aspect of the present invention,  
there is provided a stereoscopic photographing apparatus  
that has a first photographing optical axis and a second  
10 photographing optical axis, and switches picture signals for  
left eye and right eye, respectively, for each field through  
the intermediary of the respective photographic optical axes  
before inputting an image, the photographing apparatus  
including control means for controlling a photographing  
15 optical system and recording means for recording  
predetermined information of the photographing optical  
system, including control information provided by the  
control means, and information regarding whether the  
odd/even field of an input picture signal corresponds to a  
20 picture signal for the left eye or the right eye to a  
recording medium in the form of digital values, together  
with picture signals or picture signals and speech signals.

Further objects, features and advantages of the present  
invention will become apparent from the following  
25 description of the preferred embodiments (with reference to

the attached drawings).

#### BRIEF DESCRIPTION OF THE DRAWINGS

5           Fig. 1 shows a configuration of a photographing lens unit according to a first embodiment of the present invention;

10           Fig. 2 is a circuit block diagram showing a configuration of a control unit according to the first embodiment;

          Fig. 3 shows a configuration of a photographing system according to the first embodiment;

          Fig. 4 shows a configuration of a photographing system according to a second embodiment;

15           Fig. 5 shows a configuration of a photographing system according to a third embodiment; and

          Fig. 6 shows a configuration of a photographing lens unit according to a conventional example.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

20           Embodiments according to the present invention will be described in conjunction with the accompanying drawings.

(First Embodiment)

25           Fig. 1 shows a configuration of a photographing lens

unit according to a first embodiment. Referring to Fig. 1, the optical and mechanical constructions of the photographing lens unit will be described.

Referring to Fig. 1A, which is a top view, the optical system at the end adjacent to an object is separated into right and left sections. Liquid crystal shutters 11R and 11L disposed for the right eye and the left eye, respectively, operate to admit only one beam of light through either the liquid crystal shutter 11R or 11L.

The beams of light are merged into a single beam of light by mirrors 12R, 12L, and 13, and the resultant beam of light passes through a stop 21 to be formed into an image on an imaging surface via lenses 22, 23, and 24.

Fig. 1B is a front view of the lens unit shown in Fig. 1A.

Fig. 1C is a detailed diagram of a mirror mechanism of the mirrors 12R and 12L.

Referring to Figs. 1B and 1C, when a rotary knob 15 is manually turned, a screw attached to the shaft of the rotary knob 15 moves two plate arms 14R and 14L. The respective arms circularly move about rotating shafts 14RC and 14LC to allow the orientation of the mirrors 12R and 12L, which are fixed onto the plate arms, to be changed thereby to change the angle of convergence.

The rotary knob 15 is also turned to rotate the shaft



of a variable resistor 16. By reading a resistance value of the variable resistor 16, the rotational angles of the mirrors 12R and 12L can be known.

Fig. 1D is a front view showing the mechanical structure of the lens unit.

Fig. 2 is a circuit block diagram showing a configuration of a controller of the photographing lens unit shown in Fig. 1. In conjunction with Fig. 2, the configuration of an electronic control section will be described.

Referring to Fig. 2, a microcomputer unit (hereinafter referred to simply as "MCU") 291 controls the entire photographing lens unit. Reference numerals 11R and 11L denote the liquid crystal shutters already mentioned above, and reference numeral 295 denotes a driving circuit for the shutters. Driving timings are supplied in terms of synchronization signals (SYNC) from an external photographing camera, namely, the main unit of a camera, to the MCU and generated therein.

The output voltages of the variable resistor 16 for detecting the angles of convergence are converted into digital values by an A/D converter 296, and read into the MCU 291.

The MCU 291 also carries out other types of lens control in parallel. The following will describe specific

processing.

The MCU 291 controls an iris (IG) through the intermediary of a driving circuit 292.

To control the optical system, a pulse motor is driven by motor drivers 293 and 294 thereby to control a focusing motor (FM) and a zooming motor (ZM). Reset position detection switches (not shown) are connected to the respective motors so as to allow the initial positions thereof to be known. A method for finding a focal length by detecting a lens position has been disclosed in, for example, the specification and drawings of Patent No. 02807488 under the title of invention "Lens position controller and camera"; therefore, the description of the method will be omitted.

In the configuration explained above, the MCU 291 first detects the focal length of a lens from the control position of the ZM, and obtains information regarding the angle of convergence from a reading of an output voltage of the variable resistor 16. The detected values are digital.

In this embodiment, a base line length  $d$  is fixed, and stored beforehand in a memory, which is a recording medium in the MCU 291; hence, the same value will always be output.

Through a serial communication port (COM), these pieces of information can be transmitted to an external device, namely, the main unit of a camera via a mounting contact.

Thus, the MCU 291 and the communication port make up a transmitting means for transmitting the information regarding the focal length and the angle of convergence of a lens, which is the control information of the MCU 291, and the information regarding the base line length stored in the memory in the MCU 291 to an external device, namely, the main unit of a camera.

Fig. 3 shows the configuration of a photographing system that employs the aforesaid photographing lens unit or interchangeable lens unit.

First, the interchangeable lens unit will be described.

Referring to Fig. 3, reference numeral 1 denotes an optical unit 1 for stereoscopic photographing, and reference numeral 2 denotes an image forming optical unit 2 having a zooming function and a focusing function. A microcomputer 29 controls the optical unit 1 and the optical system of the image forming optical unit 2, and has information regarding angles of convergence, focal lengths, and base line lengths.

A camcorder will now be described.

Reference numeral 3 denotes a camera unit. An image obtained by the optical system described above is formed on an image pick-up device (CCD) 31. An output of the image pick-up device is processed by a signal processing circuit (Cam) 33 in the following stage so as to be converted into digital picture signals. The digital signals are

transmitted to a recording circuit (Rec) 41 of the following stage.

Reference numeral 4 denotes a recorder unit that permits recording of speech signals that have been converted into digital values (not shown) or several pieces of digital information arranged side by side in addition to the foregoing digital picture signals.

A recorder microcomputer 91 communicates with a lens microcomputer 29. Through the communication, the recorder microcomputer 91 receives the information regarding the angles of convergence, focal lengths, and base line lengths from the lens microcomputer 29. Among the pieces of information, the information regarding the focal lengths is converted into the information regarding the angles of view on the basis of the screen size of an image pick-up device. These pieces of information are transmitted to a processing circuit of a recorder unit, and recorded to a recording medium (magnetic tape) 42 so that they are arranged side by side to picture signals or speech signals.

The recorded information is read out together with picture or speech signals during reproduction, and output outside.

The signals are supplied to a reproducing device (display device) 5 in a state, wherein they are arranged side by side to picture signals or speech signals, so as to

be used as the information for achieving proper stereoscopic image display.

In this embodiment, the focal length of a zoom lens ranges from 5 to 15 mm, and a 1/3-inch CCD is employed. The angle of view can be horizontally varied from 67 to 25 degrees, the base line length is fixed to 70 mm, and angle of convergence can be varied from 0 to 3 degrees.

The information regarding whether the odd or even fields of picture signals input by switching for each field correspond to the picture signals for left eye or right eye is recorded to the recording medium 42.

Thus, according to the embodiment, first information regarding the focal length of a photographing optical system, second information regarding the base line length indicating the interval between the incident optical axes of a first photographing optical axis and a second photographing optical axis, and third information regarding the angle of convergence formed by the incident optical axes of the first photographing optical axis and the second photographing optical axis are transmitted in digital values to the main unit of a camera from the stereoscopic photographing lens unit that is mounted on the main unit of a camera, has the first photographing optical axis and the second photographing optical axis for left eye and right eye, respectively, and forms right and left parallaxes. The

foregoing three types of information, which have been transmitted, and the information regarding whether the odd or even fields of input picture signals correspond to the picture signals for left eye or right eye are recorded together with picture signals and speech signals in the form of digital values to a recording medium. It is possible, therefore, to make proper setting for reproduction and display, allowing good stereoscopic images to be reproduced.

In this case, ideally, these pieces of information are stored in the same recording medium in which the information regarding photographed images is stored. For this purpose, recent digital image storing systems can be used, because they permit various types of information, including images and speeches, to be digitized and recorded.

(Second Embodiment)

Fig. 4 shows the configuration of a photographing system according to a second embodiment. The photographing system is constructed by a digital animation photographing, recording, and reproducing apparatus, i.e., "digital video camera" and reproducing device (display device).

Referring to Fig. 4, reference numeral 1 denotes an optical unit for stereoscopic photographing, and reference numeral 2 denotes an image forming optical unit that has zooming and focusing functions. A microcomputer 29 controls the optical unit 1 and the image forming optical unit 2, and

has information regarding angles of convergence, focal lengths, and base line lengths.

Reference numeral 31 denotes an image pick-up device (CCD). An image obtained by the optical system described above is formed on the image pick-up device (CCD) 31. An output of the image pick-up device is processed by a signal processing circuit (CAM) 33 in the following stage so as to be converted into digital picture signals. The digital signals are transmitted to a recording circuit (REC) 41 of the following stage.

Reference numeral 4 denotes a recorder unit that permits recording of speech signals that have been converted into digital values (not shown) or several pieces of digital information arranged side by side in addition to the foregoing digital picture signals.

A recorder microcomputer 91 communicates with a lens microcomputer 29. Through the communication, the recorder microcomputer 91 receives the information regarding the angles of convergence, focal lengths, and base line lengths from the lens microcomputer 29. Among the pieces of information, the information regarding the focal lengths is converted into the information regarding the angles of view on the basis of the screen size of an image pick-up device. These pieces of information are transmitted to a processing circuit of a recorder unit, and recorded to a recording

medium (magnetic tape) 42 so that they are arranged side by side to picture signals or speech signals.

The recorded information is read out together with picture or speech signals during reproduction, and output outside.

The signals are supplied to a reproducing device (display device) 5 in a state, wherein they are arranged side by side to picture signals or speech signals, so as to be used as the information for achieving proper stereoscopic image display.

As in the case of the foregoing embodiment, the information regarding whether the odd or even fields of picture signals input by switching for each field correspond to the picture signals for left eye or right eye is recorded to the recording medium 42.

Thus, according to the embodiment, the same advantages as those of the first embodiment can be obtained also in the photographing apparatus combined with a photographing lens unit into one piece.

(Third Embodiment)

Fig. 5 shows the configuration of a photographing system according to a third embodiment. The system is adapted to photograph and record stereoscopic images by employing synchronized two cameras. In this system, the angle of convergence remains unchanged (parallel or zero



degree), while the base line length is variable.

Fig. 5A is a top view showing the configuration of a camera unit, Fig. 5B is a front view showing the configuration of the camera unit, and Fig. 5C is a side view showing the configuration of the camera unit.

The camera unit for right eye is composed of a lens 2R and a camera 3R. The camera unit for left eye is composed of a lens 2L and a camera 3L.

The two sets of cameras are mounted on a single rail 18 such that the right unit is fixed, while the left unit is slidable on the rail to move in the directions of the arrows shown in Fig. 5.

An interval, namely, base line length  $d$ , can be electrically known by an encoder 17 connected to the left camera. The outputs of an encoder 17 are transmitted to a microcomputer 29 where they are processed into digital information.

Reference numeral 32 denotes a circuit for synthesizing stereoscopic images, the circuit having two functions. One function is to generate video synchronizing signals, which are transmitted to the two sets of cameras, and synchronous picture signals can be output from the two sets of cameras. The other function is to select pictures. Depending on whether the circuit is outputting even or odd video synchronizing signals, the circuit alternately selects and

outputs images from right camera image output signals and left camera image output signals.

Thus, stereoscopic images based on the time sharing method are formed.

5       The microcomputer 29 outputs the information regarding the angles of convergence and the angles of view in addition to the aforesaid information regarding base line lengths. However, the values of the angles of convergence and the angles of view remain unchanged in the system, so that fixed values are always output.

10       The above three types of information are transmitted to a microcomputer of a recorder 91, and digitally recorded to a recording medium 42 by a recording circuit 41 together with picture signals or speech signals (not shown), etc. output from the synthesizing circuit 32.

15       The recorded information is read out together with picture or speech signals during reproduction, and output outside.

20       In this embodiment, the focal length of a lens is fixed to 10 mm, and a 1/2-inch CCD is employed. Hence, the angle of view is horizontally fixed to 53 degrees, the base line length can be varied from 70 to 140 mm, and angle of convergence is zero degrees.

25       The information regarding whether the odd or even fields of picture signals input by switching for each field

correspond to the picture signals for left eye (left side) or right eye (right side) is recorded to the recording medium 42.

Thus, according to the embodiment, the same advantages as those of the first and second embodiments can be obtained also in the photographing system for recording picture signals simultaneously input by the right-eye photographing apparatus and the left-eye photographing apparatus to a recording medium by switching the picture signals for each field.

As described above, according to the first through third embodiments, the details of stereoscopic conditions are sequentially recorded to a recording medium, so that the information can be retained and transmitted, allowing further proper reproduction of stereoscopic images by using the information when reproducing and displaying the stereoscopic images. Thus, the present invention provides an advantage in that good stereoscopic images can be always reproduced.

While the present invention has been described with reference to what are presently considered to be the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, the invention is intended to cover various modifications and equivalent arrangements included within

the spirit and scope of the appended claims. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

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